i tofore, this field has been solely the field of practical experience
I and of empiricism. How were we able to acquire knowledge of
/ this veritable art? I will speak from my personal experience.
* After I had finished my studies at the Institute of Mines, at
Petrograd, I left the schoolroom to enter the Salda Works of
I . *M. Demidow,* one of the best plants in the Oural.
The supervision
t of furnace work of all kinds was entrusted to an old employee,
s Pierre Chicarine, a man of very great intelligence, but illiterate,
j unable even to sign his own name. This did not prevent him in
^ any way from undertaking to design new furnaces of many types,
| and he always succeeded in obtaining good working results.
/ He was unable to state the principles by which he was guided,
despite a sincere desire upon his part to make me understand the
I reasons for the various features of the designs. This, however,
I was beyond his power of expression. His only argument was,
| "It must be done in this way; otherwise, you do not get any-
I : thing."
"Why?"
f To this he was never able to reply.
| i I still remember many of his constructions, and I am per-
suaded that he really knew nothing of the fundamental principles,
or more exactly, that he did not have any very clear comprehen-
sion of them. He made many big mistakes, which he finally
corrected after many trials. Meanwhile, from time to time, in
discussing the various furnaces, and in placing new furnaces in
operation, he gave me much important information, calling to my
attention the phenomena which took place in the furnace, teaching
me not only *where to look,* but also *how to see* that which took place.
I became greatly interested in the furnaces. I studied them
very closely, making great efforts to solve their mysteries; but
I did not make very rapid progress in so doing. It was only after
ten years that I commenced to make suggestions to my instructor

for his criticism. It was only after fifteen years that I ventured to design a new furnace for myself. My master reported after some days upon my design; fully half of it had been erased and redrawn. "It is necessary to do it in this manner; otherwise you will not be able to make it work." Thereupon my dignity as director of the works—the position which I occupied at this time—was deeply wounded; at the same time, I recognized that the veteran had reasons for acting in this manner.